B. AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (original) A therapeutic radiation source, comprising:

A. a flexible catheter extending along a probe axis between a proximal end and a distal end of the catheter, the flexible catheter comprising optical delivery means extending along said probe axis and having an originating end and a terminating end, and adapted for transmitting optical radiation incident on said originating end to said terminating end;

B. an optical source, including means for generating a beam of optical radiation directed to said originating end of said optical delivery means;

C. a radiation source coupled to said terminating end of said optical delivery means, comprising a substantially rigid housing enclosing an electron source and a target, said housing defining a substantially evacuated interior region extending along a beam axis between said electron source at an input end of the housing and a radiation transmissive window at an output end of the housing,

a. wherein said electron source and said target are disposed along said beam axis and spaced apart from and opposite each other;

b. wherein said electron source is adapted to emit electrons in response to optical radiation transmitted to said terminating end, and comprises a thermionic emitter having an electron emissive surface; and

c. wherein said target is responsive to incident electrons to emit therapeutic

radiation whereby therapeutic radiation emitted therefrom is directed through the radiation transmissive window; and

D. means for establishing an accelerating electric field extending between said electron source toward said target, the electric field acting to accelerate electrons emitted from said electron source toward said target;

wherein said optical delivery means are adapted for directing a beam of optical radiation transmitted therethrough to impinge upon said surface of said thermionic emitter, and wherein said beam of transmitted optical radiation has a power level sufficient to heat at least a portion of said surface to an electron emitting temperature so as to cause thermionic emission of electrons from said surface.

2. (original) A therapeutic radiation source according to claim 1, wherein said optical source is a laser, and wherein said beam of optical radiation is substantially monochromatic and coherent.

3. (original) A therapeutic radiation source according to claim 1, wherein said therapeutic radiation comprises x-rays.

4. (original) A therapeutic radiation source according to claim 1, wherein said optical delivery means comprises a fiber optical cable assembly having a fiber optical element extending from said originating end to said terminating end.

5. (original) A therapeutic radiation source according to claim 4, wherein the means for establishing an accelerating electric field comprises:
a power supply, having a first terminal and a second terminal, and a drive means for establishing an output voltage between said first terminal and said second terminal, said power supply being electrically coupled to said radiation source by way of said first terminal and said second terminal.

6. (original) A therapeutic radiation source according to claim 4, wherein said fiber optical cable assembly further comprises:

A. an electrically conductive cable, wherein said fiber optical element is concentrically disposed around said electrically conductive cable; and

B. an electrically conductive outer shell, concentrically disposed around said fiber optical element, said fiber optical element forming an optically transmissive core.

7. (original) A therapeutic radiation source according to claim 6, wherein said fiber optical cable assembly further comprises a first cladding shell, said first cladding shell having an index of refraction less than the index of refraction of said optically transmissive core and being concentrically disposed between said electrically conductive cable and said fiber optical element.

8. (original) A therapeutic radiation source according to claim 7 wherein said fiber optical cable assembly further comprises a second cladding shell, said second cladding shell having an index of refraction less than the index of refraction of said optically transmissive core and being concentrically disposed between said fiber optical element and said electrically conductive outer shell.

9. (previously presented)

A vascular probe having an X-ray tube as a distal end, comprising:
a flexible optical fiber having a bore through its length,
a first electrical conductor extending through the bore of the optical fiber,
a second conductor on the outer surface of the optical fiber,
an essentially cylindrical tube formed of electrically insulative and X-ray transmissive material secured on a distal end of the optical fiber, the tube having a proximal end secured in a sealed connection to the outer wall of the optical fiber, at a position spaced back from the end of the optical fiber, and the tube having a distal end and defining a vacuum chamber within the tube,

a cathode secured to the end of the optical fiber within the tube, the cathode being electrically connected to said first conductor in the bore of the fiber, the cathode comprising a thermionic cathode which is excitable by heat to emit electrons,

an anode formed within the tube near its distal end, and an anode conductor connecting said second conductor from the exterior of the optical fiber to the anode, with an X-ray target in the path of electrons moving from the cathode to the anode,

optical radiation means at the proximal end of the optical fiber for delivering optical radiation through the optical fiber, of sufficient power to heat the cathode so as to emit electrons, and

means for selectively switching electrical power to the cathode and anode to establish a potential between the cathode and anode when desired, to thereby cause X-rays to be emitted outwardly from the tube.

10. (previously presented)

A vascular probe according to claim 9, wherein the optical radiation means comprises a diode laser.

11. (previously presented)

A vascular probe according to claim 9, further including means for controlling the potential between the cathode and the anode to control the level of X-ray output from the tube.

12. (previously presented)

A vascular probe according to claim 9, wherein the anode includes the X-ray target.

13. (previously presented)

A vascular probe having an X-ray tube as a distal end, comprising:

a flexible optical fiber,

a first electrical conductor embedded in and extending through the length of the optical fiber,

a second conductor on the outer surface of the optical fiber,

an X-ray tube formed of electrically insulative material on a distal end of the optical fiber, the tube having a proximal end in sealed relationship with the outer wall of the optical fiber, and the tube having a distal end and defining a vacuum chamber within the tube between the ends of the tube,

a cathode at the end of the optical fiber within the tube, the cathode being electrically connected to said first electrical conductor in the fiber, the cathode comprising a thermionic cathode which is excitable by heat to emit electrons,

an anode formed with in the tube near its distal end, and an anode conductor connecting said second conductor from the exterior of the optical fiber to the anode, with an X-ray target in the path of electrons moving to the anode,

optical radiation means at the proximal end of the optical fiber for delivering optical radiation through the optical fiber, of sufficient power to heat the cathode so as to emit electrons, and

means for selectively switching electrical power to the cathode and anode to establish a potential between the cathode and anode when desired, to thereby cause electrons to strike the target to cause X-rays to be emitted from the tube.

14. (previously presented)

A vascular probe according to claim 13, wherein the anode includes the X-ray target.

15. (previously presented)

A flexible probe having an x-ray tube at its distal end, comprising:

A. a flexible optical fiber adapted for transmitting optical radiation incident on a proximal end to a distal end;

B. an optical source for generating optical radiation directed to said proximal end of said optical fiber;

C. an x-ray tube coupled to said distal end of said optical fiber, comprising:

a. a thermionic cathode, responsive to optical radiation transmitted to said distal end of said optical fiber and incident upon a surface of

said cathode to generate electrons; and

b. an x-ray target responsive to incident electrons emitted from said thermionic cathode to emit x-rays; and

D. means for accelerating electrons emitted from the thermionic cathode toward said x-ray target;

wherein said beam of transmitted optical radiation has a power level sufficient to heat at least a portion of said surface to an electron emitting temperature so as to cause thermionic emission of electrons from said surface.

16. (previously presented)

A vascular probe having an x-ray tube as a distal end, comprising:

A. an optical source for generating optical radiation,

B. a flexible optical fiber having a proximal end and a distal end, and adapted for transmitting optical radiation from said optical source from said proximal end to said distal end;

C. an x-ray tube coupled to a distal end of said optical fiber, comprising a substantially rigid housing defining a substantially evacuated interior region extending between a proximal end and a distal end of said housing, said housing containing a thermionic cathode and an x-ray target between its proximal and distal ends, said distal end of said housing comprising x-ray transmissive material;

a. wherein the thermionic cathode is responsive to said optical radiation transmitted to said distal end to emit electrons; and

b. wherein said x-ray target is responsive to incident electrons emitted from said thermionic cathode to emit x-rays whereby said x-rays are directed through said x-ray transmissive material of said housing;

D. means for accelerating electrons emitted from the thermionic cathode toward said x-ray target;

wherein said optical fiber is adapted to direct a beam of optical radiation transmitted therethrough to impinge upon a surface of the thermionic cathode,

and

wherein said beam of transmitted optical radiation has a power level sufficient to heat at least a portion of said surface to an electron emitting temperature so as to cause thermionic emission of electrons from said surface.

17. (previously presented)

A brachytherapy treatment apparatus, comprising:

A. a flexible probe including an optical fiber adapted for transmitting optical radiation incident on a proximal end to a distal end;

B. an optical source for generating optical radiation directed to said proximal end of said optical fiber;

C. an x-ray tube coupled to said distal end of said flexible probe, comprising:

a. a thermionic cathode, responsive to optical radiation transmitted to said distal end of said optical fiber and incident upon a surface of said cathode to generate electrons; and

b. an x-ray target responsive to incident electrons emitted from said thermionic cathode to emit a therapeutically effective amount of x-rays toward a tumorous target, in a predetermined spectral range; and

D. means for accelerating electrons emitted from the thermionic cathode toward said x-ray target;

wherein said optical fiber is adapted to direct optical radiation transmitted therethrough onto a surface of the thermionic cathode, and

wherein said beam of transmitted optical radiation has a power level sufficient to heat at least a portion of said surface to an electron emitting temperature so as to cause thermionic emission of electrons from said surface.

18. (currently amended)

A x-ray treatment apparatus, comprising:

A. a flexible fiber optic assembly, including an optical fiber adapted for transmitting ~~light~~ optical radiation incident on a proximal end of the fiber to a

distal end of the fiber;

B. an optical source for generating optical radiation directed to said proximal end of said optical fiber;

C. a power supply including a first terminal and a second terminal, and means for establishing an output voltage between the first terminal and the second terminal; and

D. an x-ray target assembly affixed to the distal end of the optical fiber and electrically coupled to the power supply by way of the first terminal and the second terminal, the x-ray target assembly including an x-ray target having at least one x-ray emissive element for emitting x-ray radiation in a predetermined spectral range in response to said optical radiation transmitted to the distal end of the optical fiber, the x-ray target assembly further including an optically driven thermionic emitter adapted to generate electrons in response to the optical radiation transmitted through the optical fiber.

19. (currently amended)

An x-ray treatment apparatus in accordance with claim 18,

wherein said x-ray target assembly includes a substantially rigid housing defining a substantially evacuated interior region extending along a beam axis between ~~an electron source~~ the thermionic emitter at an input end of the housing and an x-ray transmissive window at an output end of the housing, the housing having said x-ray target disposed adjacent said x-ray transmissive window, the housing having the input end affixed to the distal end of the ~~catheter~~ optical fiber, ~~the electron source being adapted to generate electrons in response to said optical radiation transmitted through the optical fiber~~;

wherein upon activation said power supply establishes an accelerating electric field between said x-ray emissive element and said ~~electron source~~ thermionic emitter, the electric field acting to accelerate electrons emitted from said ~~electron source~~ thermionic emitter toward said x-ray target; and

wherein said x-ray target is responsive to incident accelerated free electrons to

emit x-ray radiation whereby the x-ray radiation emitted therefrom is directed through the x-ray transmissive window.

20. (canceled)

21. (currently amended)

A probe having an x-ray tube [[as]] at a distal end, comprising:

a flexible optical fiber;

an optical source configured to generate optical radiation directed to a proximal end of said optical fiber;

a tube secured on a distal end of said optical fiber, said tube having a distal end and a proximal end, said tube comprising x-ray transmissive material and defining a vacuum chamber within the tube;

a cathode within said tube and secured to said end of said optical fiber, said cathode comprising a thermionic cathode which is excitable by heat to emit electrons; and

means for selectively providing electric power to said cathode and said x-ray target to establish a potential between the cathode and the x-ray target when desired, to thereby cause x-rays to be emitted outwardly from the tube.